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THERE ARE NONE SO BLIND AS THOSE WHO WILL NOT SEE

ROBERT V. BROWN, Biological Sciences Division, AFOSR

Touch, sight and hearing produce definite changes in the frequency and amplitude of the brain waves in man or animals, i.e., in his electroencephalogram (EEG). The size goes down as attention to the stimulus wanders, and increases sharply with attention focused on the stimulation. The decrease indicates that man is, in effect, partially anesthetized, blind, and deaf when he is not "paying attention." As he passes into light sleep, he is even further out of contact with his environment, as his brain responses to stimulation become still less.

For a long time, this loss of sensation has been considered to be strictly a phenomenon within the brain itself. Dr. Elio Garcia-Austt, Montevideo, Uruguay, with support from the Air Force Office of Scientific Research, has been studying this problem in experiments on men, guinea pigs, and rats. He has confirmed for vision, touch, and hearing that the waves which are decreased in the EEG when attention wanders are also smaller along the various sensory nerves right back to the skin, cochlea of the ear, and the retina of the eye. This means that not only is the brain inattentive and partially insen sitive, but that even the paths and presumably the sensing elements themselves are dulled.

This dulling also occurs when the attention is focused on some other stimulus. Thus, hearing may be poor if one is busy tasting something. Intense mental activity also blunts all sensations and all pathways and receptors for the senses.

The applications of these findings are widespread: A pilot cannot have very sharp vision if he is mentally busy; a husband does not hear his wife if he is interested in his television; a driver in tight traffic may be almost totally deaf to a traffic policeman. These failures of perception are not actually consciously desired. They happen because this is how the nervous system works.

TO OUR READERS

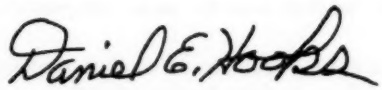
The continuing goal of the "OAR RESEARCH REVIEW" is an attempt to satisfy the information needs of both the scientist and the nonscientist decision maker, since we feel each is of importance.

It is inevitable that many decisions concerning basic research, from the budget that supports it to the manner in which it is fed into applied research and development activities, are made by people who are not scientists.

We believe that it is imperative that these people be informed about research in progress, and understand something of its potentialities. It is equally imperative that the scientist be kept up-to-date on research projects occurring within his areas of interest. Each time this publication prevents needless duplication of effort by informing a research scientist of new knowledge discovered, it will have achieved an important contribution to the conservation of the Free World's scientific resources.

Those of you among our readers who feel a need for further information about a topic covered in any issue are urged to contact the author or originating laboratory direct. Addresses for use on such occasions are shown on inside back cover of this issue.

Constructive criticism and suggestions for improvement will be most welcome, and should be directed to this headquarters, ATTN: RREI.



DANIEL E. HOOKS
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Cosmic Radiation and Van Allen Protons

Ionospheric Physics Laboratory, AFCRL

The lower fringe of the Van Allen belt may be highly irregular, and at certain points the belt may dip down to elevations as low as 180 miles. This possibility is suggested by Dr. Herman Yagoda of AFCRL, as the result of the recent study of photographic emulsion blocks orbited and recovered from Discoverer satellites during the past year or so.

Emulsion blocks carried in Discoverer XVIII on 7 December 1960 gave AFCRL scientists a clear view of cosmic radiation and high energy protons at extreme altitudes. Since then, six additional photographic emulsion blocks have been orbited, recovered and analyzed by AFCRL. From the study of the tracks in these emulsion blocks, much can be learned of the population density and the energy distribution of both cosmic rays and trapped Van Allen protons. Higher energy particles, such as cosmic rays striking the block, may pass through it, or they may produce a starlike pattern when the particle collides with an emulsion nucleus. The higher the energy of the particle, the more likely it is that a conspicuous star will be produced. Lower energy particles simply create tracks. Often these tracks terminate within the block. Such terminated tracks are known as "ender" tracks.

The analysis of the six blocks revealed several surprises. The measurements show that star intensity increased much more rapidly with altitude than expected. At the lowest altitude of about 180 miles, the star production rate was double that anticipated. (From studies of blocks carried aloft in balloons to about 120,000 feet, and Viking rockets to 158 miles, a lesser density had been extrapolated.) The increased star production at higher elevations is attributed not to increased cosmic ray density but to the interaction of the more energetic trapped Van Allen protons with emulsion nuclei.

Counts made of proton "enders" show that the number of these tracks increase exponentially with altitude in the region of 180 to 340 miles. The rapid increase in the number of these proton "enders" together with stars seems to indicate that the lower fringes of the Van Allen belt are being sampled. This leads to the conclusion that at irregular points along the polar orbit the Van Allen zone dips down to elevations as low as 130 miles.

RESEARCH ACCOMPLISHED TO DATE ... extended summary

OHIO STATE UNIVERSITY NITROUS OXIDE STUDIES

ROBERT G. DUNN, Fluid Dynamics Facilities Branch, ARL

The detonability studies at Ohio State University were made initially in a 79-mm.-inside-diameter stainless steel tube, 4 meters in length, and more recently in a 1.25-inch-inside-diameter, 5.5-inch-outside-diameter, stainless steel tube 45 inches in length. Exploding wires and a special exothermic fuze wire called Pyrofuze were used as igniters.

Results obtained in the 4-meter low-pressure detonation tube show that it is difficult to initiate detonation in nitrous oxide at the pressures investigated. Detonation could not be achieved for initial pressures up to 500 psi and initial temperatures up to 905°R. Self-sustaining flames were obtained for the higher pressure and temperature conditions, but this condition did not develop into a detonation within the 4-meter length of the tube.

In the 45-inch-long high pressure detonation tube, attempts have been made to obtain detonation in nitrous oxide at initial temperatures ranging from 535°R (ambient) to 635°R and initial pressures from 500 psi to 2200 psi. Pressure rise after ignition was monitored as a means of detecting detonation if and when it occurred. There was a pressure rise immediately after ignition at each initial pressure investigated; however, the magnitude and rate of pressure rise were such that there was no evidence during any of the experiments to date that a detonation wave was being formed. In general, the pressure rise increased with increasing initial pressure indicating more extensive nitrous oxide decomposition at the higher pressures. Under some conditions, specifically, the lower pressures and higher temperatures, no such trend was noted. The actual pressure rise observed ranged from 160 psi to 2500 psi above the initial pressure, i.e., from a fraction of to slightly greater than the initial pressure. The highest pressure rise recorded was over 2500 psi at an initial pressure of 2200 psi and initial temperature of 615°R; this actually amounted to an

explosion apparently set off when the rather slow nitrous oxide decomposition caused the temperature and pressure in the remaining unburned gas to reach the autoignition point. This work is continuing to the higher initial temperatures and pressures.

The nitrous oxide explosion limit studies were conducted in a stainless steel reaction vessel having an inner cavity measuring 1-1/2 inches in diameter and 5-1/16 inches in length. Using an exploding copper wire igniter, an explosion limit curve was established for pure gaseous nitrous oxide in the range of initial pressures from atmospheric to 700 psi and initial temperatures from 530°R to 1120°R. In all further explosion limit tests, a platinum glow wire igniter was used. With this igniter, explosion limits in gaseous nitrous oxide were established in the pressure range from 30 psi to 1100 psi and temperature range from 760°R to 1855°R.

For the mixture N_2O + 0.88 N_2, explosion limit experiments were conducted at pressures ranging from 130 psi to 3000 psi in the temperature range from 870°R to 1800°R. No reactions or explosions were observed. For the mixture N_2O + 0.88 N_2 + 0.5 AIR, a pressure range of 130 psi to 3000 psi was investigated at temperatures ranging from 1210°R to 1800°R. Again, no reactions or explosions were observed. Explosion limit experiments were conducted with the mixture N_2O + 0.25 AIR at pressures from 190 psi to 800 psi and temperatures from 1160°R to 1600°R. Reactions were observed in the N_2O-AIR mixture under some of these conditions. An explosion limit curve is being established for this mixture. A quartz pressure transducer, together with a high-frequency response oscilloscope and polaroid camera, was employed to obtain pressure-time traces for use in the study of the reactions occurring in these experiments.

Studies of the kinetics of nitrous oxide decomposition were made at OSU initially in a small constant volume bomb (inside dimensions 5-1/16 inches by 1-1/2 inch diameter), and later through use of a shock tube. Early attempts had been made to establish a nitrous oxide decomposition flame at atmospheric pressure for use in studying the reaction mechanism, but these attempts were unsuccessful.

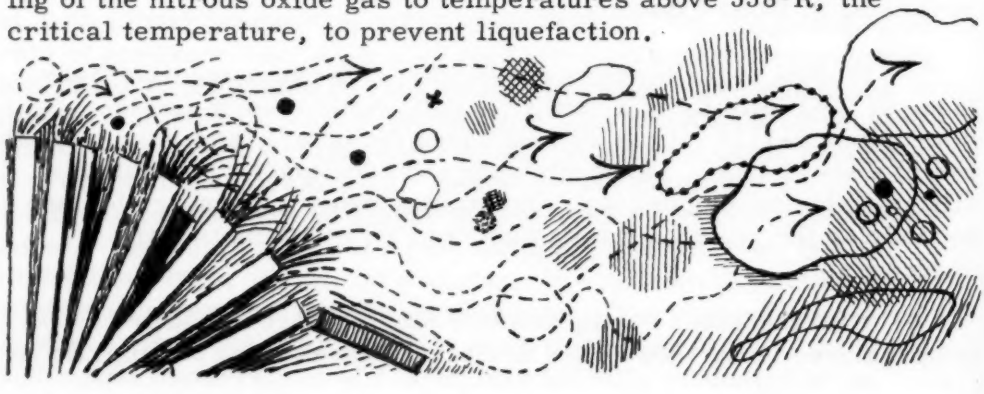
With the small bomb, kinetics studies were conducted at temperatures up to 1660°R and initial pressures up to 590 psi. Some

decomposition rates were obtained, but were not considered very reliable. A spontaneous explosion in the bomb was observed at the highest temperature and pressure condition.

At high pressures and at temperatures in excess of 1800°R, the thermal decomposition of nitrous oxide appears to be extremely rapid, so that explosions become possible. In order to study the very rapid reaction kinetics of nitrous oxide at the high temperatures and pressures, the later experiments made use of the shock tube technique, wherein the passage of a shock wave through the nitrous oxide raises the pressure and temperature rapidly. The temperature and pressure behind the shock wave can be determined fairly accurately. Pressure measurements made during passage of the shock wave, together with Schlieren photographs made through an observation window with a rotating drum camera, have been and are being made to provide qualitative and moderate quantitative information on the rate and mechanism of the thermal decomposition process. Shock tube experiments have been made at calculated temperatures behind the wave up to 2800°R and at pressures behind the wave up to 1920 psi. In one experiment, for example, at 2800°R and 735 psi, spontaneous decomposition of the N_2O was observed, with a time delay on the order of a few microseconds.

In the kinetics studies to date, only qualitative indications of reaction rates have been obtained. The work is progressing rapidly toward measurement of quantitative reaction rates throughout the pressure and temperature range under investigation.

All of the experiments -- detonability, explosion limit and kinetics studies -- in the higher pressure ranges require the heating of the nitrous oxide gas to temperatures above 558°R, the critical temperature, to prevent liquefaction.



IONIZING THE ATOM BY combustion

DR. JOSEPH F. MASI, Propulsion Division, AFOSR

Occasionally, the results of basic research efforts in one area are immediately usable in another. One such instance occurred recently when Atlantic Research Corporation of Alexandria, Virginia, largely as a result of knowledge gained in a basic research program being supported by AFOSR, was awarded a contract for a number of payloads for AFCRL's Project Firefly, a basic research program in the upper atmosphere.

Dr. Raymond Friedman and co-workers have been investigating the properties of certain solid "rocket propellants" which might be expected to produce, on combustion, plasmas with rather high concentrations of charged particles. Such propellants have high energy, and thus produce fairly high adiabatic temperatures in the combustion chamber. They also contain a large proportion of an easily ionized atom (cesium, for example).

Equilibrium calculations, carried out for the most likely combinations, indicated that aluminum with either cesium nitrate or cesium perchlorate should produce charged-particle concentrations in a rocket combustion chamber (1000 psia) of more than three per cent; moreover, the exhaust products (expanded to atmospheric pressure) should contain about 10^{17} charged particles per cubic centimeter. This is a much higher volumetric concentration than is found in the usual plasmas.

Experimental work has been carried out, and is still going on, to verify these calculations, and to determine what the properties of such propellants might be if they could be made. Many encouraging results have been obtained by using pressed mixtures of aluminum and the cesium salts. It has been shown that reasonable burning rates are obtained which are a function of the pressure used in forming the propellant strands or grains. It has been shown also that the calculated amount of ionization is indeed obtained, although precise measurements are still being sought.

Atlantic Research Corporation will design, develop, and build 36 sounding-rocket payloads for the Project Firefly experiments. An important component of these far upper-atmosphere experiments is an electron-generating combustion device which will produce a continuous flux of electrons over a substantial time interval. This device will employ cesium nitrate and aluminum.

the appearance and return of a hydrogen yield point in iron

ATTWELL M. ADAIR and ROLLIN E. HOOK, Metallurgy and Ceramics Research Branch, ARL

A few years ago, the failure of highly stressed aircraft structural steel components by hydrogen-induced delayed failure was a very serious problem. Today, the occurrence of this type of failure has been minimized, primarily because a more thorough understanding of the basic failure process recently resulted from the research of Professor Troiano and co-workers (ARL sponsored). However, gaps in our knowledge of the effect of hydrogen on the flow and fracture of iron still exist, and these must be bridged to gain the reliability required. We are, as well, striving to determine whether the behavior of all the interstitial alloying elements, such as, H_2, C, O, N in body centered cubic metals is similar in nature, since current and future materials requirements rely heavily on this class of metals.

Prior research has indicated that the effect of hydrogen on the yielding and damping characteristics of iron is qualitatively the same as that of the interstitial elements, carbon and nitrogen. It should be possible, therefore, to demonstrate that the hydrogen yield point in iron:

(a) Can be observed initially after an aging treatment following prestraining through the carbon-nitrogen yield at the aging temperature;

(b) Can be made to return after a subsequent aging;

(c) Possesses kinetics similar to the carbon-nitrogen yield point.

Using a testing temperature of -150°C and a prestraining and aging temperature of -70°C, recent research conducted at ARL clearly demonstrates such behavior.

A vacuum melted iron which contained 0.017 weight per cent nickel as the major metallic impurity, and 0.004 weight per cent carbon and 0.005 weight per cent nitrogen, was used for these experiments. A one-inch gauge length rectangular tensile specimen was used having a gauge section width of 0.187 inches, a thickness of 0.106 inches, and an average grain

diameter of about 8 x 10^{-4} inches. A strain rate of 0.05 per minute was used, and a zero suppression technique allowed the yielding behavior to be observed on a full-scale load range of 200 lbs., with an accuracy of $\pm$ 0.5 lb. in load measurement. The flow stress of this iron averages about 50,000 psi at -70°C and 82,000 psi at -150°C. Hydrogen was introduced into the iron specimens electrolytically in a room temperature 4% sulphuric acid bath for 4 hours at a current density of 0.20 amps per square inch. The specimens were removed from the charging bath, washed, dried, placed in the testing fixture and cooled to -70°C within 10 minutes.

Uncharged, hydrogen charged, and hydrogen charged and evacuated iron specimens were subjected to the following testing sequence: Prestrain 8% at -70 °C; age at -70°C for one hour under a minor load to preserve the alignment of the system; and strain 2% at -150°C. The hydrogen charged and evacuated specimens were vacuum annealed at room temperature for about 70 hours under a pressure of less than one micron. The upper-lower yield point due to carbon and nitrogen was observed initially at -70°C for all specimens. The magnitude of this yield drop and the lower yield extension were somewhat reduced for the hydrogen charged specimens, in agreement with the results of others. At -150°C, the uncharged, and hydrogen charged and evacuated iron specimens had no yield point indicating that the carbon-nitrogen yield point did not return for the aging time and temperature used, and the hydrogen charged specimens showed a yield drop of 19 lbs. (about 950 psi). Since hydrogen can easily be removed from iron under a vacuum at room temperature, the yielding behavior of the charged and evacuated specimens demonstrates that the magnitude of the yield drop for the charged specimens is a function of hydrogen in solution, and is not due to the surface damage suffered by the specimens during the charging operation.

Although the kinetics of the hydrogen yield point appearance was not determined in detail, a time dependence for the magnitude of the yield drop was observed. The magnitude of the yield drop at -150°C increased rapidly with increased aging time at -70°C, and reached a rather constant value after two hours aging time. At higher testing and aging temperatures, one observes similar kinetics for the magnitude

of the yield drop associated with carbon and nitrogen.

As mentioned previously, the hydrogen yield point in iron should return after a second one-hour aging treatment at -70°C, and the previous testing sequence for uncharged, hydrogen charged, and hydrogen charged and evacuated iron specimens was extended as follows: After the initial strain at 150°C, heat to -70°C and age one hour; then retest at -150°C. Upon straining at -150°C the second time, a large yield drop was observed for the uncharged iron specimens which was also superimposed on the returned hydrogen yield point to give an even greater effect for the hydrogen charged specimens. The hydrogen charged and evacuated specimens again exhibited a yielding behavior typical of the uncharged specimens. The entire yielding behavior of the uncharged, and charged and evacuated iron specimens at the second -150°C straining and, therefore, a portion of the yielding behavior of the hydrogen charged specimens, is believed to be due to the dislocation network and point defect generation associated with the initial plastic strain at the -150° testing temperature. This phenomenon is currently under investigation at ARL.

If the yielding behavior upon retesting at -150°C is, in fact, a function of prior plastic strain at that temperature, then straining a small amount at a higher temperature should change the dislocation-point defect network and, after a second aging treatment, allow only the hydrogen yield point to be observed again at -150°C. The testing sequence was changed to test this hypothesis, whereby the specimens were strained two per cent at -70°C immediately after heating from the initial -150°C strain, aged one hour at -70°C, and then retested at -150°C. The uncharged iron specimens had no yield point upon retesting at -150°C, and the hydrogen charged specimens had a yield drop of the same order of magnitude as before. Thus, the hydrogen yield point return can be isolated from the yielding effects associated with a previously established point defect-dislocation network.

The experimental results described herein offer a more complete understanding of the effect of hydrogen on the yielding behavior of iron, and, together with the results of previous investigators, provide unequivocal evidence that hydrogen in iron does interact with dislocations in the same manner as other interstitials.

SUPERCOOLED CLOUD and FOG DISSIPATION

Meteorological Research Laboratory, AFCRL

Cloud layers and fog have always limited Air Force operations. Aircraft have been grounded, fields closed, and such operations as parachute drops, reconnaissance missions, and search and rescue operations halted by obscuring cloud layers and fog. Techniques for clearing holes in supercooled cloud layers and fog have been under study for several years at AFCRL. Recent progress has brought the program close to economic and practical utility.

Early experiments showed that holes in clouds can be made quite easily by dry ice seeding. Spectacular, but highly variable, results were obtained. Lack of consistent performance was due to the diversity of experimental techniques used, and to the fact that no means were then available for accurately measuring from aircraft such cloud conditions as moisture content and temperature.

AFCRL and its contractors (Allied Research Associates and Technical Operations) have recently developed an entirely new machine which will make dry ice pellets from liquid carbon dioxide stored in the aircraft. This machine has been dubbed

the "Cloudbuster," because it does just that. Before the Cloudbuster development, large blocks of dry ice were carried in the aircraft and crushed into particles of indiscriminate size for seeding purposes. This technique had three limitations: The dry ice was used wastefully; it evaporated in storage; and there was the logistical problem of supplying enough dry ice blocks where and when needed.

The Cloudbuster makes dry ice pellets by passing liquid CO_2 through an expansion nozzle, and then compacting the solid dry ice powder which is formed into proper size. The Cloudbuster has been designed with the capability of making different size pellets at the touch of a lever, as well as varying the dispersal rate from two to twenty pounds per mile while flying at 130 knots.

Successful experimental tests were conducted this winter near Goose Bay, Newfoundland, from a C-130 aircraft specifically instrumented for cloud physics research. Another series of field tests will be conducted next fall to determine the best method of using this technique. The remaining tests will establish whether a single pellet size and seeding rate can be determined that will efficiently dissipate all types of supercooled clouds and fog. Of basic interest will be the time required to open a hole of a given size for a given dispersal rate.

The success of the recent Goose Bay tests was due in part to the availability of the improved cloud physics instrumentation installed in the C-130 aircraft. This instrumentation permitted the accurate measurement of all relevant parameters of the cloud layers, such as, liquid water content, temperatures at varying altitudes, and cloud turbulence. Also calibrated aerial cameras were available for properly measuring the lateral growth rates of the clearings in the seeded cloud layers.

There is an added flight safety factor available to aircraft equipped with the Cloudbuster system. The CO_2 storage tank can easily be connected to an aircraft's existing fire fighting system. This would virtually remove the danger of an unextinguishable engine fire.

Supercooled clouds, which form at below freezing temperatures, occur with increasing frequency from the upper half of the United States northward to Alaska. AFCRL is also investigating the formation and dissipation of "warm" fog and stratus clouds which develop in above freezing temperatures in all temperate and tropical regions.

When is a wall not a wall

MILTON ROGERS, Mechanics Division, AFOSR

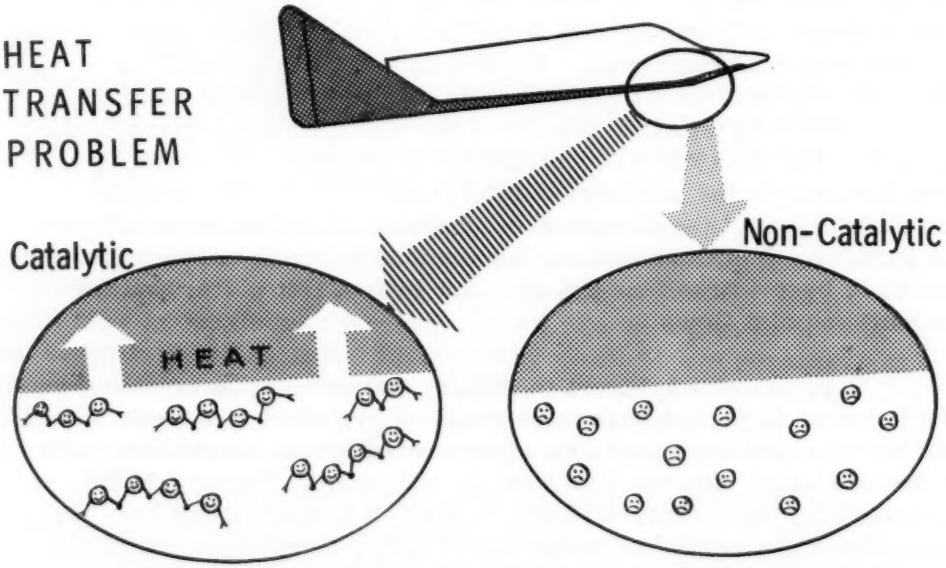
The successful design of a re-entry vehicle, or of a rocket propulsion device, may well hinge upon whether heat transfer rates can be held within tolerable limits. One of the factors that serve to aggravate the problem under certain flow conditions is the recombination of atomic species at solid surfaces. Whenever the temperature of the main stream is sufficiently high, an appreciable number of atoms may be formed; then, provided their rate of diffusion toward the wall is sufficiently large in comparison to the rate at which they recombine in the gas phase, a significant number of them may reach the wall. In such cases, it is possible to influence that portion of the heat transfer which is due to surface recombination by suitable choice of the catalytic properties of the surface. For this reason, considerable attention has recently been focused on the problem of heat transfer from the laminar boundary layer in the presence of chemical reaction at the bounding surface. Solutions embodying various degrees of approximation have been worked out for the flow over a flat plate, and for stagnation-point flows.

It is of some interest to inquire how the surface recombination behaves in the intermediate range of pressure gradients which lies between the two extremes represented by the stagnation point, on the one hand, and the flat plate on the other. Under AFOSR sponsorship, therefore, William J. Rae of Cornell Aero Lab has been studying a series of wedge flows under conditions where the chemical kinetics of recombination of atomic species in the boundary layer becomes important.

On the basis of the results presented in AFOSR 2071, "Catalytic Surface Recombination in Boundary Layer Profiles of the Falkner-Skan Type," it may be concluded that the pressure gradient has a relatively minor influence when the wall is non-catalytic, and that a more favorable pressure gradient tends to increase surface recombination when the wall is catalytic. These general conclusions are best understood physically in terms of

the two limiting cases where the wall is either perfectly noncatalytic or perfectly catalytic.

In the case where the wall is perfectly noncatalytic, no net recombination can occur at the wall: Thus, to ascertain the effect of the wall, it had to be necessarily assumed that no recombination occurs in the gas phase, the concentration of atomic species is everywhere constant, equal to its free-stream value and, hence, the concentration gradient is everywhere zero. At the other extreme, where the wall is perfectly catalytic, the concentration profiles depend only on the boundary layer velocity profile; thus, as the velocity profiles become "fuller" with increasing pressure gradient, the concentration profiles also become fuller, with an attendant increase in the concentration gradient at the wall.



Thus, the heat release due to surface recombination has been found to be relatively insensitive to the pressure gradient when the wall is noncatalytic. However, for catalytic walls and decreasing pressure gradient (i.e., more accelerated flow), the tendency is to increase the heat transfer.

The analysis presented in AFOSR 2071 also shows how the transition takes place between these two extremes of catalyticity; and between the limits of pressure gradient from separation to the stagnation point.

notice to our readers

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